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CONTENTS

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THE RISE, DECLINE, AND REVIVAL OF MALTHUSIANISM IN RELATION TO GEOGRAPHY AND CHARACTER OF SOILS*

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CONTENTS

* Presidential Address at the Washington meeting, Dec. 30, 1924.

INTRODUCTION.—It has become somewhat popular during the last few years to find an agricultural cause for many of the great historical catastrophes and to seek probable agricultural relationship to apprehended catastrophes of the future. Huntington, Simkovitch, Lord Ernle and Professor East may serve as representatives of recent writers who have been looking in that direction.

The subject is approached by all of them through the popular avenue of soil exhaustion, and in all the discussions that have taken place no one, so far as I have been able to find, has failed to assume that all soils, when man first began to cultivate them, were equally productive. It seems to have occurred to no one of these writers that soils may be fundamentally unlike naturally and that the fact of infertility in any given agricultural soil is not wholly due to man's improvidence. This attitude of mind is not confined to writers however. The western farmer sympathizes with the eastern farmer in his struggles with a "worn-out" soil and they are both inclined to assume a pharisaical attitude toward the cotton farmer who is popularly supposed to have "drugged" his soil with fertilizers until it will produce nothing unless it is continually stimulated.

In the pages that follow I shall undertake to suggest the relationship of natural soil differences to certain phases of the world's attitude toward one of the great population theories.

POPULATION THEORIES OF WRITERS.—Malthusianism did not originate with Malthus, although it had previously existed as a more or less ill-defined opinion rather than as a well worked out principle.

Malthus himself seems to have considered his work more valuable as a basis for partisan politics than as a system of universal economics. He seems to have considered any possible world-wide interest in what he was about to undertake as a secondary matter, the main consideration being the local or national British concern with his conclusions.

The attitude of statesmen and economists to the question of population prior to the end of the eighteenth century varied greatly from time to time, and largely in accordance with local and temporary circumstances. No such thing as vital statistics existed prior to the middle of the eighteenth century and for some time after that period the only statistics available were mainly indirect estimates. Even the idea now designated by the word "population" seems not to have existed prior to the time of Bacon. It is perfectly evident that no comprehensive study of such an important question, one that saw the problem from the world standpoint, could take place until man conceived clearly the idea contained in the word "population," and also clearly saw

the relation of man to the earth's resources. Man must have attained to at least an elementary degree of economic thinking.

It is equally true that, however much man may have been *able* to think in terms of population and resources, he could not have actually produced any comprehensive product as long as his limited knowledge of geography prevented him from seeing the world as a whole.

Conceptions of Early Writers.—It was impossible for the citizen of ancient Greece to conceive of a world relationship of population to resources because of his urban way of thinking and his relatively limited geographical knowledge. He saw the problem from his local point of view.

The Roman statesman to an equal extent saw it from the point of view of his political or national requirements, these pointing to conclusions directly the opposite of those arrived at by the Greek. His imperialistic attitude of mind led him just as naturally to the conclusion that the greater the numbers of the Roman population and therefore the greater the number of Roman soldiers, the greater would be the advantage to Rome. Whatever may have been the attitude of the individual Roman citizen as to the desirability of population increase, no Roman Government seems ever to have suggested any limitation or the desirability of such limitation.

The attitude of the early Christians toward the matter had no relation whatever to the food supply or to worldly comfort. The same may be said regarding the attitude of Luther. His famous statement regarding the matter, one which had for many years a profound influence throughout Protestant countries, was announced apparently on no other basis than his own conception of morality and of his belief in the intimate personal supervision of man's daily affairs by the Creator.

The French physiocrats in the years preceding the French Revolution were strongly inclined to emphasize the close dependence of population and human comfort and happiness on the food supply. Montesquieu clearly saw, in " L'Esprit des Lois," the possibility of overpopulation, and Franklin states that " There is no bound to the prolific nature of plants and animals but what is made by their crowding and interfering with each other's means of subsistence." The same idea had been advanced by Bacon, Sir Walter Raleigh, and Sir Thomas More in England long before the time of Malthus; but the possibilities in the case became acute probably for the first time through the sufferings of the French peasants in the latter part of the eighteenth century.

Three Widely Different Theories.—Three rather widely different opinions or theories developed more or less directly as the result of this

suffering. Godwin in England and Condorcet in France recognized the facts so far as they concerned the French peasants, but ascribed them not to a shortage of products but to their unequal distribution. Adam Smith also refused to recognize the conditions as permanent and undertook to show that the operation of economic forces would, in the end, eliminate the inequalities. Malthus on the other hand considered the results, at least so far as they concerned conditions in England, as the natural outcome of human inequality and implied that the conditions were irremediable in the long run and that relief measures were temporary in their effects, resulting, in the end, in evil rather than good.

Conceptions in Germany.—In Germany, however, the prevailing opinion was strongly in favor of population increase. There seems to have been practically no discussion of the possibility of overpopulation. This attitude is not to be ascribed, however, to the high productivity of German soil when compared with that of France and England or to the greater skill of the German food producer. It was due to two conditions, one local and the other, though less local, exerting its greatest influence in Germany.

The Thirty Years War was local to Central Europe. Its devastation was all but complete, and its depopulation of the country almost equally so. It is wholly unnecessary to present figures of its effects. They are sufficiently well known, and it is equally unnecessary to do more than mention the inevitable influence of such conditions on the attitude of officials and economists toward the population question.

The attitude of the Protestant Church as expressed in the famous statement of Luther, "Gott macht Kinder, der wird sie auch wohl ernähren," while not confined in its influence to Germany, exerted its strongest influence without doubt in that country. Its influence throughout northern Germany cannot be doubted. In southern Germany the influence of the Catholic Church was equally strong and operated in the same direction.

The attitude of the public mind developed under the influence of these factors has been maintained during modern times by the influence of German imperialism. All these causes were and are local to Germany, just as the causes producing the attitudes of the public mind in Greece and Rome.

Attitude of the Church.—The traditional attitude of the church toward the world as merely a brief and temporary abode for man, that such suffering as he endures here is insignificant and of no importance, except in so far as it prepares him for a fuller enjoyment of the happiness of the other world, probably had no influence in determining the

trend of opinion regarding population and the food supply. Such influence as it may have had would operate in the direction of population increase rather than otherwise.

Conceptions of the French.—The development by French writers between 1750 and 1780 of the idea of indefinite human progress and of a future rather than a past Golden Age, was an attitude of a small class of thinkers and probably had little immediate influence on the mass of French opinion. It is probable that the influence of peasant suffering during the same period, operating in a direction opposite to what may be supposed to be the tendency of the preceding, was dominant throughout France. This trend was strengthened by the pessimism that prevailed in the years immediately following the French Revolution—the period of the early Napoleonic Wars.

If the opinions that prevailed in Greece, Rome, Germany, and France were determined to so great an extent by local conditions or local political policy, they cannot be considered as indicative of general trends based on universal, rather than local, conditions. In fact it may be said that under these conditions there can be no such thing as public opinion worthy of serious consideration on a question of the kind with which we are here concerned. An opinion worthy of consideration can be developed only in places free from strong local influences such as have been ascribed.

English Environment Ready for Malthusianism.—It is apparent that the country in which an opinion based on such broad knowledge would have had the widest acceptance was England, since the influences we have mentioned did not apply to her. She had had no devastating wars for more than a century, her agriculture had been freed from the worst restrictions of the feudal system, and the influence of the Church, either Protestant or Catholic, was not exerted strongly in the direction being considered here. There seems to have been relatively little public discussion of the question even in England, but it is apparent that the prevailing opinion there would be based less on purely local conditions and more on world-wide conditions than anywhere else.

Theories of Godwin and Others.—It seems clear that it was generally recognized that suffering existed and had existed during the eighteenth century, but Godwin, under the influence of Condorcet, ascribed it not to an actual shortage, but to the unequal distribution of food under the existing social and economic system. Malthus it seems did not consider seriously the question of the abundance or shortage of the existing food supply, but rather admitted, tacitly at

least, Godwin's contention that the suffering was due to an unequal distribution of the supply.

Instead, however, of ascribing it to the imperfection of the prevailing social and economic system, he ascribed it to the natural inequalities of men, contending that any suffering which may exist is due to man's own fault—to the weakness, the inefficiency of the sufferers—and that charity tended to aggravate the matter by relieving the pressure and allowing a rapid increase of population to take place. He believed that only through the suffering that was admitted by all to exist was the population kept down within the food supply and that any increase in the latter would soon be overtaken by population increase.

His other point, and the one that was not influenced and suggested by local conditions, consisted of an attempt to show numerically the relation between the tendency toward population increase and the approximate rate of increase in the food supply. This, it seems, was Malthus' most important contribution and it is the one that has aroused world-wide discussion.

It should be borne in mind regarding it that he merely pointed out the *possibilities* of population increase, and did not claim that it ever had or ever would increase at that rate. He made it clear that under *natural* conditions uninfluenced by any inhibiting conditions, man would tend to increase at approximately that rate. Many of his critics forgot or ignored this tentative statement of the matter. He has possibly been even more criticised for his *arithmetic rate* of food-supply increase. It has been pointed out, however, by many writers since his time that this was merely Malthus' way of stating the law of *diminishing returns* as applied to agriculture. This law had not yet been formulated in such an exact way as was done later and, Malthus not being an economist, his formulation was crude. The favorable reception given to Malthus' first point by the ruling classes does not concern us here. It was due to the fact that it fitted into their wishes and prejudices rather than to its truth as a generalization.

The rather wide acceptance by thinkers of his second point indicates that it expressed what had come to be regarded, more or less unconsciously and in an ill-defined way, as a principle of universal application. It was in its essentials a crude statement of the law of the survival of the fittest.

In considering the conditions existing in England during the latter part of the eighteenth century, one is unable to find any event that could serve as an immediate cause of the general opinion that was beginning to prevail concerning the excessive increase of population. It is probable that the wave of depression spreading over Europe at the close

of the century, due to the collapse of the buoyant optimism widely prevalent at the outbreak of the French Revolution, was an important, though it may have been an unrecognized factor. It is probable however that the immediate local thing which set Malthus to thinking was the rapid increase of *rates* in England during the last quarter of the century, collected for the purpose of paying allowances to the increased and rapidly increasing industrial population. It is stated by Nitti that *rates* had been greatly increased during the latter half of the eighteenth century and that the greater the amount of money paid out in doles, or "*allowances,*" the lower became industrial wages.

This fact and Malthus' reaction to the Utopian writings of Godwin seem to constitute the immediate provocation for the work. Malthus acknowledged his indebtedness to Franklin, Doctor Price, Townshend, and several other men who had already discussed the relation of human comfort and happiness to the food supply. The idea that, without natural or artificial checks, all animals, including man, had the capacity for such rapid and continuous increase as to outrun both food supply and standing room had been discussed by all of them.

Soil Productivity and Population Theories.—None of this literature contains any discussion of the relation of any of these things to the soil. There is, however, no reason to expect that such relation was considered, since the predominant soil facts were taken for granted and assumed to be fixed and inevitable. Such a discussion would not have taken place as the soil factor was not considered a variable factor. Man's experience in western Europe had constantly tended to impress on him the consciousness of the uniformity, in general terms, of the soil factor in his environment and the inability of man to effect any fundamental modification of it. His experience throughout civilized Europe had failed to bring him into contact with more than one general kind of soil, viewed from the broad standpoint, and that kind was fundamentally of low productive power. His experience also had impressed on him the relative ineffectiveness of man's efforts, with the resources hitherto available, in greatly increasing its productivity. Having had no experience with conditions other than those in western Europe, man accepted them as fixed. No discussion of the relationship of a given factor to others is usually profitable unless the factor is a variable, otherwise the relationship is fundamentally a fixed quantity.

It is true that Malthus' theory, as finally stated, was not contingent on any given character of soil but rather on man's inability, according to past experiences, to change the productivity of that soil as rapidly as population, under favorable circumstances, could increase. The experiences of man in western Europe up to that time had shown that

his struggle against natural conditions was in no other respect as barren of important results as had been his struggle against the low productivity of the soil. He seemed to be thrust against absolute and immutable conditions.

Low Productivity of Soils of Western Europe.—It is unnecessary to undertake here to demonstrate either the natural low productivity of western European soils or man's inability, up to the end of the eighteenth century, to make any important change in it. It may be said that these soils are low in their content of all the constituents usually present in considerable quantities in productive soils, and their physical structure is such that, under continued cultivation, it deteriorates rapidly. The fact that for many hundred years man had been unable to increase greatly the yields of the principal crops may serve as a justification for the statement regarding the ineffectual struggle of man against low productivity.

Probably the most striking fact in all economic history is the almost complete lack of improvements of any kind in agriculture in western continental Europe from the time of the fall of Rome to the close of the eighteenth century. Agricultural methods and yields remained almost stationary. The yields of wheat ranged from six to ten[1] bushels per acre until the close of the eighteenth century and the yields of other crops were proportional. During the latter half of the eighteenth century, changes were in progress, consisting mainly in the addition of new crops such as potatoes, tobacco, and clover, but by the end of the century the improvement in the yield of bread grains was scarcely noticeable, except in England.

In England improvements had taken place during the latter half of the eighteenth century. These had been brought about through an increase in the livestock carried per unit area and through the increased manure made available in this way.

The predominant facts of west European agriculture, outside of England, at the close of the eighteenth century, facts that must have made themselves depressingly evident to all thoughtful men were:

1. Grain yields were extremely low. 2. They had always been low. 3. Such increases as had been effected had cost a great deal in human effort and resources. 4. These increases had been brought about only through an increase in the livestock carried. 5. Increase in livestock was possible largely through an increase in the amount of land used for growing forage for them and made necessary therefore more or less decrease in the land available for grain production.

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[1] Lord Ernle, The Enclosure of Open-Field Farms, *Journal of the Ministry of Agriculture*, Jan. 1921, p. 899.

I have already stated that neither Malthus nor any of his predecessors discussed this matter, yet there can hardly be any doubt that the consciousness of its depressing presence was one of the factors of the pessimism of the time and in the attitude of thoughtful men toward the population question at the close of the eighteenth century.

Influences of the Industrial Revolution.—Industrial development in England, through the increased opportunity for employment furnished by it, had caused a rapid increase in the urban population and an apparent rapid increase in that of the whole country. This apparent increase, resulting seemingly as a response to increased opportunity for obtaining the means of support, presented convincing proof to Malthus and the group of thinkers belonging to the same school, of the tendency of population to increase with every removal, however small, of the pressure of restraining influences, chiefly limited food supply. Agricultural history in western Europe, however, had shown no similar tendency to a corresponding increase in agricultural production or suggested the possibility of it.

These evident tendencies to population increase and to increased misery, when seen in relation to the historically demonstrated slowness with which man, with the resources then available or in sight, was able to increase his food supply, made such a pessimistic conclusion inevitable.

Change of Attitude toward Malthusian Theory.—It is well known that during the latter half of the nineteenth century, not much attention was paid to the Malthusian theory. Economic and social writers in most cases admitted, it seems, its general applicability, when any reference whatever was made to it, but considered it rather as a matter that would become important at some remote period in the future. For the present interest in it was largely academic.

The tremendous increase in human well-being, especially during the latter half of the century, is undoubtedly the reason for the shift of opinion. We are concerned, however, with the relation of the soil to this improved condition, mainly increased food supply.

If the most striking fact regarding the agriculture of the civilized world from the fall of Rome to the end of the eighteenth century be the almost complete absence of any improvement in either method or results, the most striking agricultural fact of the nineteenth century is the tremendous improvement that was made in (1) total production of bread grains, (2) the number of available food products, and (3) the distribution through all social classes of this increased supply of food materials.

It is not a matter of surprise that, since Malthusianism is a pessi-

mistic theory based on a shortage of food, a marked increase in the food supply and a much more uniform distribution of it to all classes of the population would tend to discredit the theory among most people and to relieve anxiety even among those who considered it as inevitably operative sooner or later.

Increase in Food Production.—An important increase in food production could take place in one or all of three ways: (1) through an increase in the area of land used for food production, (2) through an increase in yield on the area already cultivated, (3) through both an increase in area and an increase in yield. It is apparent that the most important factor in the nineteenth century improvement in well-being was actual increase in food production. This increase must have taken place in western Europe, since the countries that later became important producers, such as the Americas, southeastern Europe, western Asia, and Australia, did not become factors in the situation until near the close of the nineteenth century.

To what was this increased production on the relatively unproductive lands of western Europe due?

The agricultural history of the nineteenth century shows that both an increase in the area of land under crops and an increase in yield per unit area have contributed to the result. The total area of land in cultivation has been increased, covering an increase of relatively small proportions in land similar in character and potential producing capacity to that previously cultivated and a much larger increase, coming mainly in the last quarter of the century, of land of an entirely different character and potential crop producing capacity from the land in western Europe.

The yield per acre was increased very greatly by the greatest revolution in agricultural practice that the world has known within historic times. These factors will be discussed below.

Increase in Germany.—The proportional increase in the area of cultivated land (fallow land being considered cultivated land) in Germany during the nineteenth century, seems to have been considerably larger than in any of the other west European countries. The increase was made up of a part of the area devastated by the Thirty Years War, still remaining unreclaimed at the close of the eighteenth century, the lands that had been used as common pastures under the mediaeval system of agriculture, and other probably relatively small reclaimed areas. Kellermann[2] estimates the area thus added to the cultivated land of the country at 30 to 35 per cent of the total area

[2] Die Steigerung der Roherträge des Ackerlandes in Deutschland seit Anfang des 19ten Jahrhunderts, Landwirtschaftliche Jahrbücher, Vol. 35, 1906, p. 296.

of land in cultivation at the beginning of the century. He gives no estimate of the area in cultivation at that time in the countries later included in the German Empire. He states that the area of cultivated land in Prussia (the old provinces) in 1802 was 36.51 per cent of the total area of these provinces, basing his statement on the data given by Conrad in "Agrarstatistische Untersuchungen," Jena, 1872. It is very probable that this percentage was greater in the other German states than in Prussia, since soil character, climate, and topography are all of such a nature as to keep the rate of land reclamation in north Germany behind that in the central and southern parts of the Empire. As the area of cultivated land in the German Empire in 1913 was only a little less than 65 per cent of the whole area it is apparent that there could not have been as great an increase outside of Prussia since 1802, as 30 to 35 per cent.

It is probable that the increase in agricultural area in the Empire during the nineteenth century was not more than 20 per cent of the area in cultivation at the beginning of the century. The land actually in crops each year however, was increased much more than by the increase in the area of land under cultivation. This latter increase came about through the abandonment of the old system by which a third of the land had lain fallow each year. Since the change from the old to the new system did not really begin in the German states until after the beginning of the nineteenth century, the conclusion that about a third of the total cultivated area in 1802 was left without a crop each year may be accepted as approximately true. If to this be added the 20 per cent of absolute increase in cultivated area we have approximately a 50 per cent increase in the area available for crops during the nineteenth century.

Food Production in France.—According to Arthur Young[3] the area of cultivated land in France in 1789 was 75,000,000 acres, not including 5,000,000 acres in vines. Since this was cultivated largely according to the age-old 3-field system it is practically certain that at least 20,000,000 acres lay fallow each year. Young states that nine-tenths of all France was cultivated according to the ancient system. De La Vergne[4] estimates the area of fallow in 1789 at about 25,000,000 acres. Not much change took place according to De La Vergne until after 1815, but according to Ree's Cyclopedia the arable land in France, excluding Genoa, Tuscany, and the Papal dominions, in 1819 was about 82,000,000 acres, in addition to about 6 million acres of vines. According to Arthur Young there were about 27,000,000

[3] Young, Arthur, Travels in France in the years 1787, 1788 and 1789.
[4] Economie Rurale de La France, Paris, 1860, p. 55.

acres in pastures, waste meadow, and rich pastures. There were also 24,000,000 acres in woods.

In 1900[5] there were about 68,000,000 acres of land in crops and about 4,000,000 acres in vines, showing an apparent decrease in total area of cultivated land.[6] The area in grain, not including oats, in 1789 was about 27,000,000 acres and that in the same crops in 1839 was a little less than 30,000,000 acres, but in 1900 it amounted to no more than 23,000,000 acres. The use of the original fallow land for annual crops did not permanently increase the area of land used for bread grain production. It is probable that the increase due to the abandonment of the fallow system, constituted most of the increase that has taken place and the increase in the wheat acreage was not in the same proportion. The former fallow third was used under the new system for the production of other crops than wheat.

A relatively important part of the old common fields and presumably the common pastures had been enclosed before Young's time. This had no effect, however, on the system of agriculture, Young stating that the old spring grain, winter grain, and fallow system was carried on in the enclosed areas just as fully as in the unenclosed. It is probable, therefore, that the increase in cultivated area after the close of the eighteenth century due to the enclosure and cultivation of the old common pastures was not proportionally as great as in Germany.

Production in Britain.—The area of land in cultivation in England and Wales in 1808 according to the estimate of W. T. Comber[7] was approximately 29,000,000 acres. Of this 2,297,000 acres were fallow land, while a little more than 3 million acres were in wheat. The Board of Agriculture, through a committee, estimated the area of waste land in England as 6,259,470 acres and in Wales as 1,629,307 acres.

The area of cultivated land, including fallow and grass, in 1901 according to Prothero (p. 456) was, in England and Wales, 37,327,477 acres, and about 1,650,000 acres of this were in wheat. The area in wheat remained at 3,000,000 acres and a little above until about 1880.

During the nineteenth century, therefore, there was an increase of about 8,000,000 acres in the area of cultivated land in England, but apparently at no time was there an increase in the area of wheat. In addition to the twenty-five per cent increase in total area of cultivated land there was an increase presumably of practically all the fallow which constituted seven per cent of the cultivated area in 1808.

[5] Annuaire Statistique de La France, Vol. 21, 1901, p. 180.

[6] These figures do not include Alsace and Lorraine, but both were included in Young's figures.

[7] Quoted by Prothero, English Farming Past and Present, London, Longmans, 1911, p. 456. I have deducted 3 million acres of "pleasure-grounds," "ways," water ways," etc. and "Hedgeways, copses and woods."

From the foregoing it is evident that the area of land available for crop production each year was increased to an important extent in western Europe after 1800. In Germany the amount and proportion was greater than in France or England, but in the three it was probably not less than twenty per cent of the area of land cultivated before the close of the eighteenth century. The area devoted to the growth of bread grains was not increased by an equal amount and in England and France the increase was small.

Farming Practices.—The system of farming which provided for the fallowing of about a third of the land every year was not adopted because of a surplus of land. It was not adopted for the purpose of preventing an over production of grain. It had been adopted through the necessity of allowing the land to regain its productive power after having grown grain for two years in succession. It has already been stated that these lands were relatively of low productive power and demanded this period of rest at frequent intervals because of the lack of any available means of maintaining productivity without fallowing.

The mere act of enclosing did not change the character of these lands. After enclosure the same fallow system had to be continued until a better method of maintaining productivity was found. This was not long delayed. Even with the fallow the grain lands had required other treatment in order to produce even small crops. Man had long used all the manures of whatever kind available on these lands. With enclosures it became possible, through an increase in the amount of livestock carried, to increase the amount of manures available.

This factor will be discussed later, while in this connection, one of the resulting factors of considerable influence in determining the increased area made available for grain crops by enclosures will be mentioned.

The common pastures were enclosed along with the common fields so that there was probably no increase of facilities for maintaining any increased livestock by the old grazing methods. This had to be done by the growth of crops for livestock feeding. The area required for these feed crops was undoubtedly considerable and may have in some cases occupied all the increase due to enclosures. Whether it did or did not, it is evident that the area available for grain after enclosure was not increased by the amount of the abandoned fallow and the enclosed common pastures. It was undoubtedly much less.

The Agricultural Revolution in Europe and Effects.—Of far more importance in the increase in the production of food in western Europe during the last half of the nineteenth century than the increase in the area of cultivated land brought about by enclosures was the

revolution in agricultural methods which followed closely on the enclosures. This revolution may logically be called the agricultural renaissance, delayed in its advent by 300 years after the appearance of the intellectual renaissance. The latter passed over the agricultural world without effecting any awakening whatever.

The Revolution in Britain.—This revolution took place in England nearly a century earlier than on the Continent. It began in the second quarter of the eighteenth century and before the close had reached a stage of advance such as made England the model referred to by all advocates of reforms on the Continent. The second quarter of the century saw the beginning of real change from the age-old methods of handling grain land and the introduction of new crops.[8] As early as 1669 Warlidge advocated the cultivation of turnips, at the same time making it certain that his recommendation was based on very limited experience by stating "Although this be a plant usually nourisht in gardens and be properly a garden plant."

The change in methods seems to have preceded the introduction of new crops. The great advocate of the former was Jethro Tull whose mission consisted of the promotion, by teaching and example, of cultivation.

Under the old system, consisting of the growing of spring and winter grain, cultivation of the crop did not take place. The crops were not adapted to cultivation and at the present time are not grown in that way, but Tull was a strong advocate of cultivating all crops when it was possible. His strong advocacy of the operation laid him open to the charge that he considered the use of manure as unimportant. He defended himself vigorously against such charges, but stated that he was able to grow good grain crops for a number of years by cultivation alone, without the use of manure.

The lack of ready adaptability of the grain crops to cultivation made the introduction of cultivation, as a prevailing practice, very difficult. The recognition of its importance, however, hastened the introduction of new crops and had its influence in the selection, as one of the new crop plants, of a plant adapted to cultivation. This was doubtless one of a number of factors which brought about the extensive cultivation of turnips.

The introduction of cultivation, however, did not render the use of animal manures any less important as a means of maintaining soil productivity than they had been from the time civilization left the

[8] This does not refer to the change from grain growing to grazing, which took place in many parts of England two to three centuries earlier. This latter change seems not to have brought about any modification of the ancient system on those lands that were not converted into sheep pastures.

irrigated basins of the Nile and Euphrates. The world's experience up to that time had not shown any limit to the quantity of manure that could be wisely used. The need had always been greater than the supply. The introduction of turnips, a crop better adapted to use as feed for animals than food for man, suggested a way by which a greater number of animals could be maintained on a given area than formerly, and this resulted in an increased manure supply. When this was supplemented by the beneficial effects of cultivation, it became possible to maintain good yields of grain in rotation with turnips on all the land instead of on merely two-thirds of it. The recognition of the value of livestock, the increasing recognition of the importance of abundant feed both summer and winter, and the recognition of the value of clover and tame grasses for feed, especially for cattle, caused the introduction of some kind of hay or pasture crops as a standard crop of the agricultural system. The fundamental features of the revolution consisted of:—

1. The introduction of turnips as the principal cultivated crop in the system.
2. The introduction of clovers and tame grass crops as standard members of the system.
3. Following logically came a regular succession of these crops on any given field, thus establishing what has since been known as crop rotation.

These were the essential features of the so-called *Norfolk system*, established by Lord Townshend, widely advertised by Young, and adopted with local modification throughout large parts of Great Britain and later on the Continent.

The importance of the revolution thus brought about is shown in the greatly increased yields of grain and in the improvement in the numbers and still more in the quality of the livestock raised. The yields of wheat in England by the close of the eighteenth century, as shown by Young,[9] had been raised to more than 20 bushels per acre over wide areas and on soils of wide variation in character, where the new agricultural system had been adopted, supplemented by marling and liming. On soils of fair quality these yields were obtained without marling.

By these means yields had been increased from ten bushels or less during the Middle Ages to more than twenty bushels. This took place before commercial fertilizers had been heard of, and may rightly be regarded as one of the most important revolutions that has ever taken place in agriculture. The results actually achieved and the possibilities

[9] Young, Arthur, A Six Months Tour Through The North of England, London, 1770.

shown to be within man's reach were undoubtedly important factors in the decline, during the first half of the nineteenth century, in the recognition given to Malthusianism.

The Revolution in Germany.—During the last few years of the eighteenth century and the first quarter of the nineteenth a similar revolution was begun in Germany. It did not get under way until well within the nineteenth century however. It encountered more opposition than in England, partly because of the extreme conservatism of the German peasants. Through the complete failure of the Peasant Wars, the peasant class had been thrown into a position of far greater dependence than in England. Centuries of the harsh treatment received by them had made them almost inconceivably conservative and suspicious of any movement coming from without.

Not only was the revolution later in beginning in Germany than in England but it proceeded at a much slower rate after it began. Even as late as the middle of the nineteenth century there was still as much as 15 per cent of the agricultural land in Germany in fallow and about 9 per cent as late as 1878.[10] According to Kellermann[11] it amounted to about 4.69 per cent in 1900. Many of the large estates continued the old grain growing system well into the sixties. Von der Goltz shows that at the close of the eighteenth century German agriculture was still essentially mediaeval in its methods, its crops, and in the social and economic condition of the peasants. The results achieved in Flanders and England were attracting widespread attention among leaders, but reforms were not effected to any significant extent until after the close of the century. The work of Thaer[12] emphasized the same reforms that had brought about such striking results in England, consisting mainly of enclosures, introduction of crops adapted to cultivation and the control of weeds, the increased growing of forage crops, and the growing of more and better livestock, the latter to be effected both through better breeding and better feeding. The most important feature in the series of reforms was the increased livestock to be carried. The main reason given was the greatly increased quantity of manure that would be furnished for increasing the productivity of the grain land. The struggle was, as for many previous centuries, against the low productivity of the German soil.

The results expressed in increased acre yields of wheat was not so

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[10] Von der Goltz, Geschichte der Deutschen Landwirtschaft, Stuttgart, 1911, Vol. II., p. 257.

[11] Op cit. p. 295.

[12] Grundsätze der rationellen Landwirtschaft, (new edition) Berlin, Paul Parey, 1880.

striking as in England. The yield of wheat in Germany at the close of the eighteenth century was somewhat less than 10 bushels. By the middle of the nineteenth it had not risen above 16 bushels.

In France the conditions as depicted by Young[13] were essentially like those in Germany. With the exception of a small area in northeastern France and certain relatively unimportant areas elsewhere the agriculture was wholly mediaeval in its rigid adherence to the old three-field system. The growth of a spring grain crop was followed by a winter grain crop and this in turn by fallow. The yield of wheat at the close of the eighteenth century ranged around 8 to 10 bushels. Reforms came slowly even in the nineteenth century, the yield amounting only to 14 bushels by the middle of the century. It is not surprising that the Malthusian doctrine was not discredited as early in France as in Germany and England.

Summary of the Effects of the Revolution.—Summing up the changes effected up to the forties of the nineteenth century, listing the results in a formal way, we have:

1. The abandonment of the centuries-old three-field system.
2. The introduction of tillage and the resulting reduction of weeds.
3. The establishment of a regular rotation of crops including a cultivated and a forage crop with only one grain crop in the simplest rotation.
4. The growth of forage crops.
5. Great increase in the livestock carried per unit of land in crops.
6. Great increase in the amount of manure produced through increased stock, better feeding, and better care and preservation of the manure.
7. Important increase in the area of land available for crops each year.
8. The establishment of agricultural education.
9. The winning by agriculture of a respectable place among the industries of mankind.

The Food Problem a Bread Problem.—The food problem of the world has always been a bread problem. History has shown the possibility of an active and productive life without meat or with a very small proportion of meat in the diet. For the solution of this problem, therefore, the introduction of livestock was not so important as it may seem. The new method required the use of an important part of the land solely for the purpose of making the rest more productive for grain. The discovery by which man could avoid this use of a considerable part of the land, in order that an increase in the productivity

[13] Young, Arthur, Travels in France in the years 1787, 1788, and 1789.

of the rest might be possible, had not yet been made. Notwithstanding this fact there was an important increase in the quantity of bread grains produced. The total production of wheat, barley, and rye in Germany in 1800, basing an estimate on Kellermann's statement of the percentage of cultivated land in Prussia at that time and assuming that the percentage was somewhat higher in the other states that later formed the Empire, was about 250,000,000 bushels.

In France according to the estimate of arable land made by Arthur Young[14] and De La Vergne[15] and the yields worked out by the Bureau of Agricultural Economics in the U. S. Department of Agriculture the production was about 250,000,000 bushels. In England according to Prothero[16] it was about 80,000,000 bushels, making a total at the beginning of the nineteenth century of 590,000,000 bushels.

These same countries produced in 1900 about 1,260,000,000 bushels of grain, being practically an increase during the century of 100 per cent. A superficial examination of the yields, such as can be obtained at various times during the century, indicates that some 60 per cent of this increase came before the use of commercial fertilizers became general in these countries and may, therefore, express the results of the improvements made in agricultural methods.

The Development of Agricultural Chemistry.—The development of agricultural chemistry, beginning just before the middle of the nineteenth century constituted the next step made by civilized man in his age-long struggle with soils of low productivity. The results achieved in this field are due more to the work of one man than to any other, though chemistry had been in progress of development for many years. Liebig[17] is justly regarded as the originator of this great improvement.

Liebig was able to show the importance of certain mineral elements to agriculture, doing his work in the laboratory and drawing his conclusions on the basis of his laboratory work rather than on direct experiments. His conclusions were extremely radical and stated in extravagant form. Whatever may be said, however, of his many changes of opinion during his long life and of the theoretical basis on which his agricultural conclusions were drawn, it is true nevertheless that he started the development of what has grown into the widespread practice of the use of chemical fertilizers.

Chemical Fertilizers.—It would be out of place here to undertake

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[14] Travels in France in the years 1787, 1788 and 1789, London, 1794, page 475.

[15] Economie Rurale de La France, depuis 1789, Paris, 1860, page 55.

[16] English Farming, Past and Present.

[17] Justus Von Liebig, 1803 to 1873. Author of many books and papers on scientific subjects. For a general review of his work in its bearing on agriculture see Von der Goltz's Geschichte der Deutschen Landwirtschaft, Vol. II, pp. 278-300.

to discuss the much argued question as to whether mineral fertilizers act directly as plant food or in some indirect way. It is sufficient for our purposes to state that there is no argument about the fact regarding the benefit derived from their use. Increased yields of all crops have been brought about by their application to the soil, the increase being effected for the first time by the application to the soil of a material that had not been taken from it. Its use did not constitute a return to the soil, in smaller than original quantity, of material temporarily removed for the maintenance of life. It constituted a distinct, independent addition to the soil of material that it had not previously contained.

By the use of these materials increased production on all the soil, rather than on part of it as had heretofore been the case, was possible.

In continental Europe chemical fertilizers had not been used previously to Liebig's time, though guano had been used in England for a quarter of a century. The use of mineral fertilizers may be said to date from Liebig's time. Guano, used earlier, cannot be considered as exclusively a nitrogenous fertilizer, though it had an organic origin. Following rapidly on the discoveries of Liebig came the discovery of deposits of phosphates, the fertilizing value of basic slag from the steel mills, new deposits of guano, the nitrate deposits of Chile, the phosphate beds of the United States and north Africa, and finally the immense potash deposits of Germany and later of France.

In 1859 Germany, according to Von der Goltz, imported 6,600 tons of nitrate salts, in 1878 somewhat more than 166,000 tons. After this the guano beds began to approach exhaustion and basic slag took first place as a phosphatic fertilizer. In 1900, however, there was used in addition to a large amount of basic slag, about 48,000 tons of guano and 960,000 tons of Chilean nitrate. The use of fertilizing materials was encouraged through the appearance, beginning as early as 1868, of a great body of literature discussing the principles and describing the practice in great detail.

Effects of Use of Fertilizers.—This extensive use of fertilizers had an immediate effect on crop yields. It has already been stated that the yield of wheat in Germany in 1850 was considerably less than 20 bushels per acre. It stood around this figure until about 1885 when it began to rise, slowly at first and more rapidly afterward, until in 1906 it had reached 30 bushels.

In Great Britain it had reached 30 bushels by 1897 and in 1906 stood a little below 35 bushels.

In France the increase was slower but it was marked. In 1840 it stood around 14 bushels, by 1896 it had reached 20 bushels and has

stood around that figure since. Chemical fertilizers have never been as extensively used in France as in Germany, while the high yields in England and to a less extent in Germany, are due to heavy imports of feed grains, which have expressed themselves through yields. The relatively small acreage in England, permitting the selection of the best lands for wheat, has been a factor of no small importance in the high yields obtained there.

The changes thus far described, in so far as they concern the subject under discussion, have consisted of an increase in the area of land under crops brought about partly through the abandonment of the ancient system wherein a third of the land lay fallow each year and partly through the use of land not hitherto used for crop production, and through an increased yield on all the cultivated land.

Expansion of Grain Area.—The next advance in production of breadstuffs came about through an increase in the amount of land under cultivation, resulting from the utilization of large areas of land not heretofore extensively used for grain production by the people of western Europe, north of the Alps. They were used for grain production in small areas to supply the demands of the great cities of ancient Greece and Rome, but the areas so used included not the great bodies of such lands but isolated small areas occurring within the Mediterranean basin and the fringes of those large areas where they bordered some of the Mediterranean waters.

The great bodies were not touched however, partly because they were not needed and partly because they lie so far within the great continental areas that it was impossible for them to be reached by the available means of transportation. The Mediterranean region belongs geographically to the belt in which these soils lie, but owing to recent geologic changes a region which pedologically belongs to south Russia and west Siberia was broken up into a complex of small areas, some of which retain the characteristics normal to the geographic belt in which they lie and others have become essentially equivalent in soil character to western Europe.

Mountain building forces have raised many areas into climatic zones entirely different from the normal of the belt. Vulcanism has covered large areas with easily disintegrated basic rocks or unconsolidated accumulations with chemical and mineralogic characteristics identical with the indurated volcanic rocks, and the prevailing topography has promoted the widespread occurrence of young unleached soils by the rapid rejuvenation of the soil through erosion of any leached surface horizon. The ever present soil movement on slopes has prevented the formation of soil profiles unfavorable to plant growth.

The northern shores of the Black Sea, the Plains of Thessaly, Thrace, and Macedonia, considerable areas in Asia Minor and Syria, Sicily, and northern Africa, all of which retain the soil characteristics normal to the belt in which they lie, soils equivalent to those of south-central Russia and western Siberia, were able to supply sufficient grain for the support of the cities of Greece and Rome, aided by grain from irrigated Egypt.

After the Mediterranean region ceased to be the center of European civilization, when northwestern Europe became densely populated, these small areas and fringes of large areas of grain lands ceased to be the sole supply of bread grains for Europeans. They seem not to have continued to maintain their original relation to the Mediterranean population, as large areas went out of cultivation because of nomadic invasions. In ancient times these lands had, seemingly, the same effect on the less productive lands of the Mediterranean basin, through the competition of their cheaply produced grain, as the grain produced on the great continental areas of the same kinds of soils have had on the grain produced on the less productive lands of Germany, France, and England during the last half of the nineteenth century.

It is not improbable that the decline in Roman agriculture, about which much has been said, was as much due to declining productivity of Italian soil as the decline in wheat growing in England during the last fifty years has been due to declining productivity of the soil in England. Both have competed with the same thing under somewhat similar circumstances with similar results.

Soils of Eastern and Western Europe Compared.—I am stating what you as geographers know already when I state that the foregoing refers to the dark colored lands of the world; but it is possible that not many of us have seen the full significance of these lands as factors in the recent history of the world, and still more do many of us fail to realize their relation in characteristics to the soils that up to fifty years ago constituted by far the larger part of the cultivated lands of the world.

In practically every respect the soils predominating in these great areas are widely different from those on which European agriculture, outside the Mediterranean basin, had been built until fifty years ago.

The soils of western Europe are light in color, these are dark.

The soils of western Europe are low in organic matter, these are high.

The former are low in lime as a rule, these are invariable high.

The former are low to medium in potash content, these are high.

The former are low to medium in phosphorus content, these are medium to high.

The former have a poor structure or develop such a structure in a

short time under cultivation, these have a pronounced granular structure and retain it well under cultivation.

The former lose their organic matter rapidly under cultivation, the latter lose it very slowly.

The former fail to utilize the full force of the sun's rays in storing up heat, the latter utilize it much more fully. The former were covered with timber and could be reclaimed for agriculture very slowly, these were covered with grass and could be reclaimed for agriculture rapidly.

The former occupy, for the most part, regions with rough topography; these lie usually on smooth areas.

These areas possessed the combined advantages of high productivity, features promoting their rapid and cheap subjection to agriculture, and their utilization on a large scale after subjection. None of these characteristics were ever possessed by any considerable areas of the land that had been previously cultivated. Their utilization, as it actually took place, introduced a factor into the world's agriculture incomparably more effective as a bread producer than any factor that had ever been introduced into the situation before, without regard to time or other circumstances. It was the world's greatest agricultural event, if the production of breadstuffs be regarded as the most important aim of agriculture.

Accepting the comparison made above in which it is shown that these soils possess the characteristics differentiating them very distinctly from those of the soils on which agriculture of western Europe has been based, it may seem surprising, if they possess such important advantage as producers of bread grains, that they were not utilized at a much earlier date.

There are doubtless many reasons for this, but it seems clear that the following are among the most important.

Late Utilization of Dark Colored Soils.—Until man had developed the modern engines of civilization, especially modern facilities for communication and transportation, it was necessary for him to live in a region that supplied him with a large part of his necessities. He had to supply himself not only with food but with water, building material, and fuel from his immediate environment. The black lands of the world are treeless, they are streamless for a considerable part of the year over wide areas, and ground-water usually lies deep. Each settler must provide himself with all of the different kinds of food necessary for maintaining life and health. The black lands are predominantly adapted to grain production and not to a wide range of

In Europe, prior to the eighteenth century at least, the question of products.

local defense probably demanded much more consideration than in modern times, and a wide expanse of smooth, open grass land does not supply abundant natural opportunities for defense.

Another reason for their late development lies in the fact that because of the nature of the soil and of the topography of their occurrence, they are predominantly adapted to mass or large scale production. Because also of the climate of these regions, the climate that has been the predominant factor in their development, they are not adapted to small scale production. Their development came only after large scale utilization of these lands had been made possible through the invention of agricultural machinery.

This fact, however, should not cause us to confuse the results effected by the natural characteristics of these regions with that effected by machinery. The latter did not increase, significantly at least, the production per acre or probably the total product obtained from them, though it shortened the period of their development from uncultivated to cultivated land and enabled their utilization to be effected by a much smaller number of men than would have been required without machinery. The final result is essentially the same by either method. The number of men required by the one that was applied was much smaller than the other would have required.

It is not necessary to go further with this matter. It is evident that the wide open plains of the world did not offer advantages to the poorly protected individual or small community in the way of soil productivity that could overcome the many disadvantages that they presented.

Areas of Dark Colored Soils.—These soils occupy large areas in the interior of the two northern, North American and Eurasian, continents, an area of considerable size in South America, and one of unknown extent in Australia. A smaller area is known to occur in India and a few relatively unimportant areas in Africa. In the Eurasian continent, they occupy an area of not less than 500,000 square miles lying mainly in south central Russia, western Siberia, eastern Roumania, and the plains of Hungary. In North America they occupy a belt somewhat less than 100 miles in width extending from the Peace River country in Canada to central Texas, a distance of about 2,000 miles. In South America they occur, with somewhat imperfect characteristics, over an area of about 100,000 square miles. In Australia and India the area covered is not known.

Modern international trade in breadstuffs is based almost entirely on the product of these lands and their subjection to the plow and the beginning of large scale grain trade took place at the same time.

In the United States wheat exports by decades from 1800 to 1850 amounted in millions of bushels, to .5, .5, .25, .2, .5, and 1.5 In 1870 it amounted to about 40, in 1881 to 126, and in 1896 to 180 million bushels, this latter being the highest total reached in any pre-war year. It is well known that the grain lands of the Great Plains states began to produce wheat in the late seventies, coinciding practically with the beginning of our export of wheat.

In Russia, grain exports increased from an average of a little more than 76 million bushels per year in the five year period from 1866 to 1870 to about three times that quantity in 1894[18] and to 494,500,000 bushels in 1911.[19]

The exact relation of increased grain production in the latter part of the nineteenth century in Australia to the opening up of land comparable in character to those being placed under cultivation for the first time in other parts of the world is not known. It is apparent that no one has attempted to describe the character and geography of the soils of Australia in any other terms than geological and such description is of no value for the purposes of the correlation here attempted.

It is well known, however, that a considerable area of such soils is found in Australia and there can be very little doubt that it is mainly responsible for the rapid expansion of wheat production within the last fifty years.

In 1860 the production amounted to 10 million bushels. Thirty years later it had not trebled, standing at 27 million bushels. In 1900 it stood at 48 millions, less than twice what it amounted to in 1890. Between 1900 and 1910 it doubled and by 1915 it reached a total of 180 million bushels. The relatively slow rate at which this increase has taken place, compared with the rate in other countries, indicates that the area of typical black earth in Australia, comparable in quality with that in other countries, is relatively limited.

The remaining country in which wheat production has increased greatly during the last fifty years is Argentina. It has been definitely determined within the last few months that a considerable part of the Argentine plain is covered with soils that are comparable to those now being considered. It is also well known that until within the last thirty to forty years the greater part of this region was occupied by stockmen rather than grain growers. The statistics of exports of grain from this country are very significant. Exports of wheat in 1880 amounted to

[18] Brockhaus' Konversations Lexikon, Vol. 14, page 72.

[19] An Economic Study of Russia before and during the War, U. S. War Trade Board, Unpublished Data.

about 70 thousand bushels; in 1890 to 11 millions; 1900 to 66 millions; 1905 to 99 millions; 1910 to 66 millions; 1915 to 85 millions; and 1918 to 100 millions. A striking fact brought out by these figures is the rapid rate of increase from 1890 to 1905 and the lack of any increase since that date.

EFFECTS OF INCREASED GRAIN PRODUCTION ON MALTHUSIANISM.—Now that we have these facts of breadstuff production and are able to understand the reasons for the production some one may legitimately ask what it all has to do with Malthusianism. It may be replied that they have very little to do with the theory as it was originally announced, as it has not been shown that the same trend is to continue indefinitely. The theory included as one of its postulates that every increase in food supply tended to be overtaken by population increase, since the latter contained the capacity to increase at a greater rate than food supply. The world had had no experience, previous to the time of Malthus comparable to that of the last fifty years, and had the tremendous increase in grain production that has taken place in late years, taken place a hundred years earlier Malthus would probably never have been heard of and the theory to which his name is attached would not have been promulgated until a later date and by some one else. Since the time of Malthus the production of breadstuffs has more than doubled in less than twenty-five years in a number of countries. Whether there has been more than a hundred per cent increase in the total world production of breadstuffs or their substitutes in twenty-five years or less is a question that seems not to have been determined. Whether it may have happened or not is a matter of relatively little importance. The fact about which there can be no doubt is that an increase in food production at a rate hitherto undreamed of took place, and whatever may be thought of its effect on the Malthusian theory, there can be no doubt whatever that it had a tremendous effect on the popular attitude to the theory.

Increase of Dark Soil Areas not to Continue.—Any permanent influence that these facts may have on the theory is dependent on the possibility of the same rate of increase being maintained for an indefinite period. To state the case almost answers the question in the negative. It will be recalled that increased production during the nineteenth century has been due to four factors: (1) The revolution in methods beginning in England well back in the eighteenth century and on the Continent in the early part of the nineteenth. (2) The increase in the available land through the abandonment of the three-field system. (3) The discovery and extensive use of chemical fertilizers. (4) The bringing into cultivation of large areas of productive virgin land.

It is admitted that the invention and use of agricultural machinery has enabled the work of modern production to be done by a small number of men, and the building of railway lines has promoted the rapid utilization of these lands by making it possible to dispose of the product, but the machinery and the railways would have been ineffective without the increased production which in the final analysis depends on the four factors above given.

The question of the possibility of maintaining the rate of increase attained during the last fifty years for an indefinite period of time is easily disposed of. In the case of the first three of the factors listed above, it is sufficient to say that the law of diminishing returns has already been in operation. It is fundamentally impossible for the past rate to be maintained through the operation of known methods. It should be borne in mind, however, that the increased production by the first three factors was not sufficient to permit any significant development whatever of world trade in breadstuffs, and the modern industrial populations of western Europe and eastern America could not now be fed if it had to depend on the soils and production areas to which those factors have been applied. Modern grain trade is a product of the opening up of the dark colored lands of the world.

The maintenance of the past rate of increase in production, and in fact the maintenance of even a small increase in production is dependent on either the effecting of an agricultural miracle, or an indefinite increase of production on the black lands. It is really dependent on the possibility of an indefinite expansion in area, since we have seen that increase by all other methods is limited by the application of the law of diminishing returns. There are two ways however, by which an increase could possibly be maintained: (1) By increasing the production on the dark colored lands now cultivated, and (2) by an increase in the area of these lands.

Increasing the Yield of Dark Colored Soils.—It has just been stated that any attempt to increase the yields on these dark colored lands already in cultivation would be subject to the operation of the law of diminishing returns. There is, however, another factor that enters into this case. The use of fertilizers or manures, the means by which yields on the light colored lands had been effected during the nineteenth century, is supposed to be due, possibly to the supply of a certain amount of actual plant food elements which are lacking or present in small quantities in the natural soil, and probably to a very considerable extent, possibly to a major extent, to the maintenance of a favorable physical character in the soil or to favorable moisture relations. With regard to the possibility of increasing yields on the dark colored lands

by the use of fertilizers it is evident that we must consider the nature of these soils. The materials usually constituting fertilizers consist of organic matter, some form of nitrogen, potassium, phosphorus, and lime carriers. In other words these substances are added to the soils and the increased results are without reasonable doubt due to a deficiency in quantity or an unadaptability of form in the soils to which they have been applied.

The dark colored lands have a very high content of all the constituents named above except phosphorus, and a higher content of the latter than the light colored soils. It is apparent theoretically therefore that the application of these substances to these soils would meet with little response. Such experimental data as is available confirms this conclusion. There is still another factor in the matter however. The limitation of crop yields on these lands is not determined by the nature of the soil but by the amount of moisture available. They occur necessarily, not accidentally, in areas where the rainfall is low, and the moisture available for the growing crop is often short. The size of crop rarely expresses fully the inherent capacity of the soil for production. This being the case it is evident that the same treatment which has brought about a large increase in crop yields on the light colored lands of western Europe would not be equally effective on the dark colored soils. The same conclusion may be drawn regarding the application of better methods of cultivation, though probably to a less degree.

This being the nature of these soils, and the climatic conditions of the regions in which they lie being such as they are, it is evident that any considerable increase in acre yield on these lands above what may be considered their initial or virgin capacity will be brought about with much more difficulty than was experienced in effecting an increase over the natural virgin productivity of the light colored soils.

It seems therefore that any future increase in grain production on these lands, at least in considerable proportions, must be brought about through the subjection of additional dark soil acreage to cultivation.

It is unnecessary to discuss this possibility at length. In the United States it is well known that not only is practically all of the productive dark colored land already under the plow, but much of this land that is not productive has been cultivated for several years. It is evident to any one familiar with the situation in the United States that there will be in the final adjustment a restriction rather than an expansion of dark land grain acreage.

In Russia and Siberia the data available do not warrant a definite conclusion. The trend of exports from Russia before the World War

offers a suggestion, however, that the greater part of the good land has already been put under the plow and that the future rate of increase will decline rather than increase or remain stationary. The exports increased rapidly up to 1911 and then began to decline, the amount in 1912, '13 and '14 being considerably below that for the previous years since 1905.

The production in Australia fluctuates over so wide a range that it seems fair to conclude that wheat growing has already been pushed well into regions where the climatic conditions are very uncertain. A future expansion on a large scale of wheat production in Australia is not highly probable.

Argentina as a Grain Producer.—The entrance of Argentine into the world wheat market in the closing years of the nineteenth century has received a great deal of attention. Her exports were insignificant up to 1885. Soon after that they began to increase by leaps and bounds reaching a maximum in 1905. Since that time they have remained practically stationary. Recent studies of the region warrant the conclusion that the future expansion will be slow. The production will probably increase slowly but it is certain that any increase equivalent to that taking place from 1890 to 1900 is not to be expected.

The situation in Canada seems to be different from that in the other countries mentioned. A large total area is still available for agricultural expansion.

Potentialities of Canada.—The acreage in wheat in Canada was about 20 million in 1900, but by 1923 it had reached 23 million acres with a production of nearly 400 million bushels, half as much approximately as our own production. It is reported that not more than a fourth of the available wheat lands in Canada have been placed under cultivation.

Virgin Areas in Eastern Asia.—The world has been rather completely covered in a general way to the extent that the location of the large areas of dark colored lands are rather well known. It has already been stated that the areas in Africa are small and such as are in existence will probably be found to be more valuable for the production of other crops than for grain. A considerable area bordering the Gobi Desert in eastern Asia seems to be the only one of any considerable size not yet placed under the plow wholly or in part. Its possible production, however, would attain a figure of very small size when compared with the world's existing production.

THE REVIVAL OF MALTHUSIANISM.—Standing where we stand and looking back over the revolution in production taking place during the last century; realizing that Malthus and his predecessors as well as his

contemporaries lived near the close, but still within the Middle Ages so far as food production is concerned, we cannot wonder that his theory suffered an eclipse through the greater part of the latter half of the nineteenth century. When one examines the arguments advanced against it by its opponents, however, he is struck for the most part by their failure to see the true state of affairs. While no classification of these arguments has been attempted, a casual perusal seems to indicate that most of them failed to see the relation of increased production of food *per man* and increased production per unit of area. They failed to recognize that the final test of the theory hangs on the possibility of an indefinite increase in production per *area* and that the increase per man may be a source of *evil* to the majority of mankind rather than of good. If the law of diminishing returns be an inexorable one it seems merely a matter of time when the law of material limitation of population will operate much more mercilessly than at any time in the past; for it is evident that the future contains lurking within it no possibility of such an increase in production as has taken place during the last half century through the utilization on a large scale for the first time in the history of the world of the black soils of the world.

In view of the events of the past fifty years, it may seem surprising to many of us that there should have been in the last few years a revival of interest in the Malthusian doctrine.

Comparing existing world conditions, however, with those existing at the time when the doctrine was announced in completed form, we must recognize that in at least one important respect they are similar. The close of the eighteenth century was marked by the widespread appearance of a feeling of pessimism due to the collapse of the buoyant hopes of mankind created by the French writers preceding the French Revolution and by the events taking place in the early years of the revolution. Its failure caused a complete collapse of these hopes and threw the European world into despondency.

We were thrown into a similar attitude by the events of the second decade of this century. Added to this more or less psychological attitude must be reckoned the undoubted actual food shortage existing during the war.

Whatever other causes have contributed their portion to this revival of interest in the doctrine with which we are concerned, the World War has undoubtedly been an important one.

TITLES AND ABSTRACTS OF PAPERS

Washington Meeting

Esther S. Anderson (Introduced by Nels A. Bengtson).

The Beet Sugar Industry of Nebraska as a Response to Geographic Environment.

Nebraska now ranks fifth among the sugar beet producing states in the Union.

The well-drained silt loams and the very fine sandy loams of the terraces of the Platte, North Platte and the Republican river valleys of western Nebraska are good soils for the beet culture, because they contain the necessary ingredients for beet growth and because they have proper textures to make them retentive of moisture. The looseness and the depth of the surface soils and the subsoil make it possible to produce roots of uniform shape and good size. The differences in elevation of the terraces are ample to insure good drainage.

The large number of clear days, 138-160, during the growing season, and an average daily summer temperature of 69°-72° F. with fairly large diurnal variations are favorable climatic conditions. The rainfall is supplemented by irrigation.

The sugar content of the beets seems to vary especially with the differences in the amount of rainfall and the number of clear days during the harvesting season,—September, October and November. The highest percentage of sugar occurs when the October and November sunshine is abundant and the rainfall is low.

Sugar beets, wheat and alfalfa are the major crops grown in western Nebraska. During the last decade alfalfa reached its highest production in 1917 before the extraordinary high prices were paid for sugar beets and wheat; the beet-sugar industry reached its maximum in 1920 when the beet prices were highest, and the wheat obtained its peak in 1922 directly after the sudden decline in beet prices. Since the highest points of production of these crops come in different years, the farmers generally have one good money crop, and the rotation of crops aids in maintaining favorable soil conditions.

Due to the extension of irrigation and the development of intensive farming, such as characterizes sugar beet culture, the population has increased rapidly and western Nebraska has become a prosperous industrial-agricultural area.

Wallace W. Atwood and Rollin Salisbury Atwood (Latter introduced by Wallace W. Atwood).

Physiographic Stages in the Evolution of the San Juan Mountain Region and Their Correlation with the Physiography of the Front Ranges of Colorado.

The physiographic stages in the evolution of the San Juan region have been worked out through a series of extended field studies by the senior author, and with the co-operation of Dr. Kirtley F. Mather. The junior author, in association with Dr. Homer P. Little, worked out during the past season the sequence of events in the physiographic history of the Front Ranges of Colorado. In this paper the correlation of these two studies was presented. Five stages are recognized in the erosional history of each region; at least three stages of Pleistocene glaciation are proved. There is not a simple correspondence of relief features and erosion surfaces in the two regions; but the two histories include great diastrophic or orogenic movements that find expression in each of the regions. The relationship of the physiography of the mountain region to that of the Grand Canyon Plateau to the southwest, and to the Great Plains to the east, was also presented.

Wallace W. Atwood.

Geographical Research.

One of the chief purposes of this Association has been the promotion of research in the field of geography, and it seems appropriate at this time to pause and take stock as to just what progress we are making. We may recognize that at no time in the history of this country has there been such notable advances under way in geographical research as at present. The significance of such research work to our industrial and commercial activities, to various phases of government service, and to our progress in education, will be emphasized in this paper. The increasing demands for geographical research, and for expert services of geographers, will also receive attention; and the qualifications necessary for the prosecution of such research will be dwelt upon. The knowledge of geography is proving to be of greater and greater significance in our economic life, in government service, and in education.

Nels A. Bengtson.

Geographic Aspects of the Industrial Development of Honduras.

The alluvial lands of the Coastal Plain region have become the seat of the greatest industry of Honduras, that of banana production. The development of this industry has proceeded from the Motogua River

valley in the west to the Colorado in the east, comprising a little more than one-half of the north coast country. This has been facilitated by three principal factors, viz.: 1. Nearness to the Gulf ports of the United States; 2. Exceptionally fertile and well-drained soil, in this respect superior to the low uplands of extreme northeast Honduras; 3. Nearness of mountains to the coast and the lowlands along the river valleys, which have been cut through them, thus affording storm-sheltered areas of large extent peculiarly well adapted to banana production.

The Sierra region is characterized by short mountain ranges separated by deep structural basins into which have been incised canyons with intricately ramifying tributary systems. The mountainous upland presents evidence of two peneplains, the upper one at altitudes of 3,300 to 4,500 feet, and the lower one at 2,500 to 3,000 feet. In connection with the major streams are found two distinct terrace systems with altitudes varying from 2,000 to 2,400 feet for the upper and from 300 to 1,000 feet for the lower. The gently sloping lands of the interfluves of the peneplains and the flat lands of the terraces are the areas of interior Honduras best adapted to agricultural development. Elsewhere the slopes are mostly too steep to permit of stable soil if the forest cover should be destroyed.

The peneplains have been so severely dissected that the resultant topography presents a mountainous relief. This constitutes a serious barrier to development of modern transportation facilities. Streams are still actively incising their channels, floodplains are wanting in most places, the gorges are subject to heavy raging floods, and hence construction of railways or automobile highways will involve a tremendous amount of grading and bridge building.

Variability of rainfall is another factor of first magnitude to be considered. Even along the rainy north coast in some years there are 50 to 60 inches less of rainfall than other years. Records show that in some months at the height of the rainy season but little rain falls. January, for instance, shows for one place 43.10 inches for one year, and only 4.17 inches during the same month of the following year. Any given area thus has to overcome conditions of both drouth and flood in order to develop successful tropical agriculture.

Industrially Honduras is now a unique combination of the new and the old. In the Caribbean Coastal Plain from Trujillo westward, American capital and skill has transformed a reputed fever-zone into a region of agricultural and industrial prosperity. But within a day's muleback journey from that zone the "land of tomorrow" still is dominant. Until modern transportation facilities conquer the hurdles

of difficult topography, industrial progress is impossible because of lack of economically available markets for the products.

Hugh H. Bennett.

Some Geographic Aspects of Western Ecuador.

The paper describes the physiographic, climatic, vegetative and soil conditions of the Pacific lowlands and their relation to present and future agriculture and population.

Robert M. Brown.

The Attributes of Civilization.

Not a philosophical discussion, but an attempt to define the term "civilization" and state the limits of its use in the various stages of school geography.

The conclusion is reached that in the elementary grades, the differentiation of peoples into races and stages of culture is unnecessary and inadvisable. The teaching here cannot go beyond the essential brotherhood of man.

Later in the secondary schools, the broadening knowledge demands a different view; and here, not forgetting the teachings of the earlier grades, may be introduced the idea of advanced and backward peoples. Regional studies would prevent these terms from being opprobrious.

At a still later stage when the knowledge of peoples becomes more definite and detailed, another classification may be desired. Here is the time to introduce the terms, savage, barbarous, and civilized. These however must be used carefully and with full appreciation of their intent.

W. D. Collins (Introduced by O. E. Meinzer).

Relations between the Quality of Water and Industrial Development in the United States.

Census reports show a consistent growth of industrial activity west and south from New England and New York where early industrial development centered. This movement is from areas where natural waters are clear and soft into areas where the waters are turbid or hard. Industries which demand clear soft water have been slower to move than those less dependent on such supplies. The comparatively undeveloped areas where clear soft water can be found are the logical locations for future extension of certain industries. The increase in general industrial activity in areas where the natural waters cannot be used economically will lead to a corresponding increase in the business of treating waters to make them suitable for the various industries.

N. H. Darton.

Geologic Evidence as to the Age of the Temple of Cuicuilco, near Mexico City.

During the past summer a study was made of portions of the Valley of Mexico to ascertain the age of the ruins of the pyramidal temple, Cuicuilco, probably the oldest edifice on this continent. This pyramid is surrounded by the lava flow of the Pedregal which covers human remains of various kinds. Consideration was given to the history of the lava flow, its date, and its relations to the lake deposits of the valley. The work was done for the National Geographic Society, which is also cooperating with the Mexican Government in excavating the pyramid.

D. H. Davis.

Urban Development in the Kentucky Mountains—Read by Title.

The existing literature, both in the field of serious contributions and fiction, conveys an erroneous idea as to present day conditions in the Kentucky Mountains, due to the recent rapid change associated with the development of the coal resources of the area. Though urban development is still limited, there were 38 towns with populations of 500 or over in the "Mountains" in 1920 and the number has increased since that date. By comparison with other portions of Kentucky, the *number* of towns with populations of 1,000 or over represents practically average conditions for the state.

Towns are in all cases located on main drainage lines in the area of creek bottom settlement, as lines of communication focus upon the principal valleys which also afford the only suitable city sites. In the area of ridge top settlement, the location of towns may be independent of drainage lines and closely related to rail routes which do not follow stream courses. For the area as a whole, the dominance of drainage lines in determining city sites has favored a marginal location for the larger foci of population.

Town plans are in few cases distinctively southern in character. Regional topographic conditions and the association of urban growth with recent mining development have resulted in both compact and attenuated urban communities, but the court house is seldom the center around which the town is built.

The diversity of cause which has led to city growth has also resulted in various types of communities. Some are mining camps expanded to city size, others are only indirectly dependent upon the coal mines. In a few cases, towns are still centers for rural communities only.

In marginal locations, the diversity of interests in the towns increases greatly.

In the urban centers of recent growth, the character of the development is surprisingly good. Paved streets, sewer systems and a satisfactory water supply are common. Schools, hotels and the buildings which house the business of the community are substantial structures of brick, stone or cement. In appearance, these towns compare favorably with those of similar size in most portions of the country.

Future urban development will probably be confined to a multiplication of small centers as a result of topographic conditions. Only in marginal locations are the physical conditions favorable for the development of large cities. The most favored margin is the northern, which has witnessed most development in the past and here also may be expected the maximum development in the future.

W. M. Davis.

A Climatic Classification of Oceanic Islands—Read by Title.

Oceanic islands, chiefly of volcanic origin, may be classfied on a climatic basis, because the forms that they assume after their eruptive growth is completed, vary according to destructive processes to which they are then subjected, and these processes are unlike in several climatic zones. In the frigid zones, islands are covered by glaciers, which erode great troughs in their slopes. In the temperate zones, islands are furrowed by streams and cleft by waves. In the warmer seas of the torrid zone, islands are, as a rule, protected from erosion by encircling coral reefs, and are therefore furrowed by streams but not cleft by waves—except that in their growth, before protecting reefs are formed, they may be cleft.

In the marginal belts of the frigid zones, islands were formerly glaciated and still show the effects of glacial erosion. In the marginal belts of the coral seas, islands temporarily lost their protecting reefs during the glacial period, and they were then cleft. Further details regarding these islands are presented in the paper.

V. C. Finch.

A Detailed Map of an Agricultural Area.

This report was intended to exemplify the principles noted in the preceding paper. A map was presented to show the land of Verona Township, Dane County, Wisconsin, distinguished by color into classes of use. The classes were determined through detailed field survey.

Since the area reported upon is small and primarily agricultural in character, the explanation of the map consisted principally of an inter-

pretation of the adjustment of crops and systems of farming to the glaciated, unglaciated and intermediate topographic and soil sections that characterize the region. It was noted that there has been a failure to adjust the assessed valuation of the farm land to the relative topographic advantages and disadvantages of these sections, a condition which is to the detriment of the farmer in the unglaciated area.

J. Paul Goode.

Progress in Cartography in Poland.

Since the Armistice wonderful things have been done in cartography in Poland. Under the old regime all Polish maps were made in Vienna, or Leipzig or Gotha, by German map makers. Prof. E. Romer of Lwow began before the ink was dry on the armistice, to build a cartographic institute in his home town and university. The venture is highly successful, backed by the Teachers' Cooperative, or the University. Atlases and maps of small and large scale, of the highest quality are being turned out at a surprising rate. The institution, at first called "Atlas" has recently honored its founder, and is now called the Romer Geographic Institute.

E. S. Greggs (Introduced by Helen M. Strong).

Transportation Problems in Tropical America.

Gilbert Grosvenor.

Some Recent Work of the National Geographic Society.

W. H. Haas.

Physical Conditions of the Inner Amazon Basin.

The inner Amazon Basin is a region of tremendous size which lies within a few degrees of the equator. It is low-lying, subject, in large part, to inundations. The temperatures are only moderately high and the rainfall is not excessive, neither is the humidity exceptionally high. The fixed population relatively is extremely small. This unquestionably is due less to climate than to the fluctuating waters of the Amazon, resulting in periodical flooding of the more accessible parts. There are many attendant results of this flooding.

W. H. Haas.

The American Indian and Geographic Studies.

In spite of a natural interest in things Indian, the geographer has added little or nothing in interpretation. He has been interested chiefly in economic, less in political, and scarcely at all in social geog-

raphy, the field in which most Indian studies lie. As in organic so in cultural evolution there is a fairly complete adaptation to the environment. These cultural adaptations are exceptionally well shown in the activities of the American Indian, an untouched field by the American geographer. Even the economic activities of the white men were, and still are in Latin American countries especially, modified by the presence of the red man. Perhaps even more far-reaching has been the effect on the Indian's natural environment by the coming of the white man. Geographic studies along any or all of these lines are bound to be fruitful.

Richard Hartshorne (Introduced by J. Paul Goode).

The Significance of Lake Transportation to the Grain Traffic of Chicago.

Analysis of the factors underlying the importance of the Chicago grain market, emphasizes the following: (a) the location of Chicago on the eastern margin of the area of densest grain production, the area producing nearly half the surplus of corn and oats in the United States and a minor part of the wheat surplus; (b) its commercial facilities for handling and marketing grain, including in particular the terminal elevators, the futures market, and the local consuming market for corn and oats, developed in part because of the traffic itself; (c) the advantageous position of Chicago with reference to rail and lake routes to eastern and European markets, dependent largely on its location at the head of Lake Michigan.

Lake transportation is of significant advantage to the grain trade of Chicago because of (a) its relation to the development of railroad routes, services, and rates; (b) the additional facilities and routes of transportation provided; and (c) the direct advantages, chiefly those of lower costs, which result from the use of lake routes of shipment. Lake transportation is used only occasionally for receipts from the northwest, but is important for shipments of grain to northeastern United States and western Europe. In this movement Chicago as the southwestern terminus of the Great Lakes Waterway is the most advantageous port of shipment from the producing areas of most of the central west and the southwest.

At the present time lake transportation is used for only about a third of the total eastbound shipments of grain from Chicago. The use of the lake routes for grain shipments from Chicago is a result of the low cost of lake transportation, but is curtailed by the closing of the waterway because of ice during a third of the year, and, to an even greater extent, by the incompleteness of the Great Lakes Waterway which

prevents the large lake vessels from reaching the eastern markets and seaports.

The relative importance of lake shipments as compared with total eastbound shipments fluctuates greatly from year to year, due chiefly to fluctuations in the total movement through Chicago, but also to fluctuations in the export movement, and to yearly variations in lake rates and other minor factors. Eliminating these annual fluctuations, it appears that during the decade before the War the relative importance of lake shipments declined from about one half the total eastbound shipments to but little over one-fourth, largely because of a decline in the export movement from the United States. Increased exports during and after the War, particularly by way of the St. Lawrence River route to Montreal, have caused an increase to the present figure of one-third the total movement.

Preston E. James (Introduced by Kenneth McMurry).

Geographic Factors in the Trinidad Coconut Industry.

Coconuts and coconut products occupy a position of great and increasing importance on world markets. Perhaps no other commodity would illustrate to better advantage the problems of tropical agriculture.

The coconut palm is rather narrowly limited by its climatic, soil, and drainage requirements. These are as follows: 1. It must have a tropical rainy climate. 2. It must have a loose sandy soil through which the roots can penetrate with ease, and through which the water can drain easily and completely. A dark colored sandy loam is the ideal soil, although coconuts are found thriving on what are apparently sterile sands. 3. It must have a constant and rapid supply of ground water.

These conditions are found in three parts of Trinidad, all of them along the coast. One is on the east coast; one on the north coast; and one, the Cedros District, on the southwestern peninsula.

A detailed study of one typical estate in the Cedros District shows that coconuts are much affected by the variations in rainfall. The influence is felt a year later in yield and in size and quality of nuts.

Copra is shipped from many parts of Trinidad, but the process of drying the coconut meat differs. In the Cedros District where the rainfall is less, the copra is dried in the hot sun. In the East Coast District, on the other hand, there is so much rain that the copra is dried in big houses heated by steam.

Coconuts are grown in many parts of Trinidad where conditions are unfavorable because of poor drainage, or of a stiff clay soil. Un-

fortunately new coconut estates are being planted in these poor areas, due to the present high price of coconuts and the depression of the cacao market. Thus high market prices are retarding the trend toward a closer adjustment to the natural environment, and in so doing, are retarding the establishment of agriculture on a permanently sound basis in Trinidad.

Mark Jefferson.

Malthus in the Light of Subsequent Events.

Malthus, living on the eve of the age of Steam, feared that men would multiply so fast on the earth that some day they would be brought into terrible distress by hunger.

Abundant statistics of the hundred and twenty years that followed have not justified his fears. Food has become over-abundant and population shows distinct signs of being checked by another agency that operates independently of food supply. There is little likelihood that the world will ever be really crowded.

W. L. G. Joerg.

Human-Use Versus Natural Regions: A Preliminary Report of the Committee on the Geographic Provinces of North America.

This report of the committee, which consists of Messrs. O. E. Baker, C. R. Dryer, C. O. Sauer, R. De C. Ward, and, as chairman, the reporter, was presented mainly to solicit an expression of views in the subsequent discussion. The definition of geographic provinces being intentionally left in abeyance, the motive that led to the creation of the committee was stated to be the desire for the establishment of regions that are related to man's activities, in contradistinction to regions that are purely physical. After a brief review of various endeavors to extend Herbertson's natural regions method on the human-geographical side, by Roxby (*Geogr. Teacher,* 1907), Unstead (*Geogr. Journ.,* 1916), and Dryer (these *Annals,* Vol. 5, 1915), the latest examples of regional subdivisions of North America were discussed more fully. These are M. C. Stark and D. S. Whittlesey's "Major Geographic Regions of North America" (1923; principles first applied in Stark's "Geographic Regions of South America," 1922), O. E. Baker's map of the agricultural regions of the United States (latest published version, *Yearbook [Dept. of Agric. for 1921*), and J. Russell Smith's "North America" (1925: principles first applied in his "Human Geography," Book Two, 1922). With this development as a background the questions were raised: Is it or is it not sound in the delimitation of regions to add human and economic factors to the physical

factors of relief, climate, and vegetation as criteria? Or should the endeavor rather be to establish natural regions and "cultural" regions separately in order by their comparison to arrive at an interpretation of the life of a region?

A paper of substantially the same content was read by the chairman at the meeting of the British Association for the Advancement of Science at Toronto in August, 1924, before Section E (Geography) to elicit the views of British and Canadian geographers on these questions.

Neil M. Judd (Introduced by Gilbert Grosvenor).

Prehistoric Pueblo Bonito.

Pueblo Bonito, a prehistoric Indian village in northwestern New Mexico, is now being explored by the National Geographic Society. Four years have already been devoted to these investigations; the work will be brought to conclusion in 1925.

As a result of the Society's researches, much new information has been brought to light concerning the daily life and the cultural influence of the pre-Columbian Pueblo peoples of the southwestern United States, and especially those of Chaco Canyon. The ruins of Pueblo Bonito embody the architectural ideas of two distinct groups of people; these inhabited the village contemporaneously during a considerable period but one was pioneer to the other. Occupancy of this site was continuous throughout many centuries.

The ancient Bonitians were agriculturists by choice and cultivated large areas of now sterile soil. Their primitive wealth was such as to induce inter-tribal commerce with native peoples on the Pacific coast and in the valley of Mexico. It also prompted periodic attacks from neighboring, nomadic tribes—attacks which obviously hastened final abandonment of Pueblo Bonito.

C. F. Marbut.

Relation of the Amazon Valley to the Future Food Supply of the World.

H. A. Marmer.

Mean Sea Level and its Variations.

In this paper was presented the results of a study on mean sea level and its determinations, the particular features treated being the definition of mean sea level; its variation from day to day, month to month, year to year and the causes of these variations; methods for determining mean sea level and correcting for these variations.

F. E. Matthes.

Evolution Basin.

The basin of Evolution Creek and its surrounding peaks, named for Darwin, Huxley, Spencer, and the other "evolutionists," constitute a little-known region of exceptional scenic beauty and scientific interest, situated at the head of the South Fork of the San Joaquin River in the heart of the Sierra Nevada of California. Probably few localities in the United States afford better opportunities for the analytical study of cirques, U-canyons, canyon steps, rock-rimmed tarns, and other features of glacial sculpture, nor exhibit more clearly the influence of the rock structure on the development of these forms.

But aside from its glacial features the region is of broad physiographic interest because the principal parts of its landscape can be definitely assigned to certain of the older erosion surfaces of the Sierra Nevada, and as a result of studies that have been carried northward to fossil bearing localities in their range, their age can now be given tentatively. The U-valley of Evolution Creek, it would appear, is essentially a valley of Pliocene age, modified by glaciation; its shoulders and hanging valleys are presumably of late Miocene age, and so is Evolution Basin itself, which is situated at the same general level. Again, Mount Darwin, which stands 3,000 feet higher, bears on its summit remnants of a gently undulating surface of still earlier age.

Alexander McAdie.

Special Maps for Charting Storm Movements.

It is desirable owing to the deflective effect of the earth's rotation and the consequent deviation of moving air from a true N-S motion that such deviation shall not be exaggerated by the use of maps, which themselves distort areas and directions. Storm tracks for example plotted on Mercator projections, also on some other projections, assume a path which is far from being the true path and so may give rise to wrong impressions of storm movements. Several new equal area maps were shown, and storm paths plotted.

There is also offered a plea for a general use of kilometers and the metric system in calculations of area and speed.

G. B. Roorbache.

The Relation of Foreign Trade to Present Day New England.

R. H. Sargent.

Discovery of Aniakchak Crater, Alaska.

During the summer of 1922 a large crater six miles in diameter, which was named Aniakchak Crater, was discovered by W. R. Smith,

Associate Geologist, and myself while on a reconnaissance trip along the Alaska Peninsula.

The paper related the details of the discovery of this crater and gave a description of the amphitheater and the surrounding country.

H. L. Shantz.

The Agricultural Potentialities of East Africa.

Ethiopia and the country extending south to the northern boundary of the Dominion of South Africa comprises an area of two million square miles. The twenty million inhabitants depend almost entirely on agriculture. At the present time almost one million acres are in European plantations and possibly twenty million acres are under native cultivation. From this great area the agricultural export amounts to only about 4 million pounds sterling. The potentialities of the region are very great, about 14 per cent of the area is adapted to the production of coffee, bananas, and temperate cereals, fruits and vegetables. Here maize, wheat and flax are grown successfully. The larger part of the area or about 63 per cent is suitable to the production of warm climate crops, such as cotton, maize, sorghum, ground nuts, and tropical fruits and vegetables. The remaining 23 per cent is semi-desert and is excellent grazing land but of low carrying capacity. This area could compete with Europe and America in such crops as maize, cotton, citrus fruits and livestock. The extreme physical possibility for cotton production would be more than twice as large as the similar area in the United States. Sparse population and the backward character of the natives, not the lack of a suitable physical basis, are the cause of the present low production of agricultural exports.

William J. Showalter (Introduced by C. C. Colby).

The Monroe Doctrine and the Countries of the Caribbean.

Wherever the Monroe Doctrine has not applied in the countries of the Caribbean, and the United States, the British Empire, France and Holland have controlled the destinies of the people, good government has prevailed, the inalienable rights of man have been respected, peace has been perennial, and a prosperity far beyond that of any tropical country of similar status, except in the character of the government, has obtained.

Under the shelter of the Monroe Doctrine the governments in Caribbean countries have exploited the masses under peonage systems, worse in some directions than our slavery system. The rights of the minority are seldom respected and revolutions are the only method of ousting the party in power.

J. Russell Smith.

An Example of Local Variation in Tropical Climate.

The north coast of San Domingo is flanked by a mountain range about 2,000-2,500 feet high, trending slightly NW-SE.

South of this range is a valley with Samana Bay on the east and Monti Christi Bay on the west. There is no sharp divide between the two rivers draining this continuous valley.

The highest point in the valley road is 209 meters. Seven miles to the eastward at an elevation of 185 meters, there are rich farms of bananas, cassava, yams, and royal palms, indicating a good moisture supply.

Four miles east of the divide the cactus appears.

Eighteen miles east of the divide, at an elevation of 128 meters, there is only low open forest with many cacti 10 to 15 feet high, and goat pasture is the chief economic utilization.

This enormous contrast seems to be produced by the change of slope which continuously forces the air upward (a very little) until the divide is reached after which, the descent of the air (even a little) produced enough aridity to create another botanic and agricultural world.

J. Russell Smith.

Geographic Mythology as Evidenced by the Facts and Prevailing Teachings about Tropical Agriculture.

I passed through such schools as happened to be in my way, got a college degree and doctor's degree and began teaching geography in college and at the same time found myself believing the following myths:

1. All mankind has passed through or is in some of the stages of evolution containing the following steps: a. hunting stage, b. pastoral stage, c. agricultural stage.

2. The natives of great area of central Africa and central South America are savages who live by hunting and fishing.

3. The American Indian east of the highlands of New Mexico is a nomad, living in portable wigwams and making his living by hunting and fishing.

I knew the Indian grew corn but it did not disturb the above mentioned myth.

Many authorities, for example, Dr. Gilmore, of the Museum of the American Indian, 156th & Broadway, New York City, attest that at an unknown antiquity man developed a primitive hand agriculture in nearly all parts of the world where the climate permitted it, the ex-

ceptions being the tundra, cold northern forests and the dry deserts. Elsewhere he cultivated, usually by hand, a great variety of crops—In the tropic forests of Africa, for example, bananas, corn, cassava, pumpkins, beans, rice, tomatoes, peanuts and other vegetables. For full description see Bruhnes, "Human Geography," pp. 350-368; Report No. 95, Office of the Secretary, U. S. Dept. Agriculture, Possibilities of the Canal Zone, 1912, Taylor and Bennett. Both of these sources indicate the roving character of this agriculture, moving after two or three crops, much as the corn and cotton farmers of the southern United States have done for so many decades.

American school texts can be said on the average to contain almost nothing about this agriculture.

This may be said to indicate the following:

1. Need of some one to discover anthropology and introduce its interesting findings into American elementary education.
2. Incomplete and accidental instruction of American geographers.
3. Incomplete state of mere descriptive geography.
4. Lack of appreciation of geography as a science, for as a science the adjustments of primitive agriculture are as valuable as adjustments of larger groups, such as New York City and Switzerland.
5. Unfortunate lack of perspective which makes us look at the world purely in the light of our own culture and regard the tropic denizen only as one who does or does not contribute raw materials for our factories and markets for our trade.

Edward L. Stevenson.

Certain Erroneous Interpretations of New World Geography as Recorded in the Work of the Early Cartographers.

The lingering ideas of Antiquity and of the Middle Ages respecting World Geography very naturally influenced the interpretation of the Geography of the New World in the early years of trans-oceanic discovery. Aside from the influence of time-old traditions there were the real geographical conditions—much the same then as now—and for an understanding and interpretation of these, the early discoverers and explorers exhibited an intelligent interest, which fact is strikingly entered in the contemporary cartographical records.

Errors of interpretation there were, and, as touching details, these were almost numberless. All too frequently there has been a disposition on the part of historians of the period, to overlook the contemporary point of view, and all too many have shown themselves in "bondage to the modern map."

The interworking of the real and the imaginary geographical condi-

tions exhibit important and interesting facts which we find set down in the work of the early cartographers.

In this presentation it is proposed to enter only the borderland of the infinite number of details, to note but a few of the larger problems coming within the scope of the suggested theme.

Helen M. Strong.

Changes in Entrepôt Markets for Tropical Products.

During the last ten years international traffic in many tropical and other exotic products has been more or less rerouted. The greater share of those from the Middle East which includes roughly India, southeast Asia and the Islands from Sumatra to New Guinea are sent direct to the United States through either Suez or Panama rather than by way of the entrepôt markets of northwest Europe.. Although the War brought about a sudden change in ocean trade channels the tendencies for this rerouting appeared with the opening of the Panama Canal in 1915 and the increased financial and commercial importance of the United States.

Products from tropical and adjacent subtropical regions make up almost the entire value of agricultural imports, and comprise, together with such exotic commodities as silk, nearly one-third of the total imports into the United States. Such prewar purchases totaled about $600,000,000, and those for 1923 amounted to nearly $2,000,000,000. The four principal imports are silk, sugar, coffee, and crude rubber comprising together more than half of all the tropical, subtropical and exotic imports into the United States. In value they amounted in 1923 to more than $1,000,000,000.

Asia, Europe, North America and South America before the war accounted for 99 per cent of all tropical and exotic products imported into the United States, but in 1923 nearly half of these commodities came from Asia, about 30 per cent from North America, approximately 14 per cent from South America, and about 4 per cent from Europe. Asia has supplanted Europe as the immediate origin of these commodities.

Glenn T. Trewarthe (Introduced by V. C. Finch).

The Dairy Industry of Wisconsin as an Adjustment to the Natural Environment.

The evolution of Wisconsin's agriculture from the period when wheat growing absorbed almost the entire interest of the farmers to the present condition of dairy specialization is a narrative of economic adjustments to the natural environment and to changing economic conditions. The remarkable success which Wisconsin has achieved in

dairying is due, in a measure at least, to the fact that in turning to dairy industry her farmers were directing their energies into channels in which the physical environment was cooperating for success.

The milk from Wisconsin dairy cows in 1923, which was put to some commercial use, was consumed in four principal forms. Named in order of their importance they were: cheese, butter, condensed milk, and fluid milk. For various reasons, some of them geographic and some not, the manufacture of these several dairy products has tended to localize in rather definite areas. As an example, the largest area in which a major portion of the milk is sold in the fluid milk market is in the extreme southeastern counties of Wisconsin, adjacent to Chicago and Milwaukee. Geographical proximity to great urban markets has largely determined the location of this specialized dairy area.

There are two large areas within the state where, largely as a consequence of the unfavorable natural environment, dairying has not developed. One of these is northern Wisconsin beyond the Wisconsin terminal moraine, and the other is the Potsdam sandstone region in the central part of the state.

S. S. Visher.

The Rainfall Regime as a Great Handicap to Tropical Development, with Special Mention of Australia.

The rainfall of most of the tropics, as compared with that of middle latitudes, is far more variable from place to place, from season to season, and from year to year. Likewise a larger share of it falls as heavy showers, reducing its usefulness and often causing floods.

The great local contrasts in rainfall were illustrated from Queensland, eastern Brazil, western Ecuador, and several islands in the West Indies and the Pacific.

Sharp local contrasts in average rainfall are detrimental to development because they greatly increase the difficulty of satisfactory adjustments to environment. Illustrations were given in respect to crop varieties, dwellings, equipment and methods.

Most tropical areas have well marked seasons of rainfall but some only a short wet or dry season, and others have half the years wet and the other half dry. Still others have two wet and two dry seasons. The dry seasons, as well as yielding certain advantages, are detrimental in desiccating vegetation and soil, drying up water-supplies, and leading to a harmful amount of dust.

In order to compare the monthly variability of rainfall in low and middle latitudes a planimeter measurement was made of Supan's map on percentage range of mean monthly rainfall. This revealed

that low latitudes had over three times as large an area possessing a monthly variability of over 20 per cent as is the case in mid-latitudes and twice as large a percentage of their total area has this range. In respect to the most uniform rainfall type, where the range between the driest and wettest months is less than 10 per cent, mid-latitudes have nearly six times as large an area as low latitudes.. This type comprises about 26 per cent of the total land area of mid-latitudes while it makes up only three per cent of low latitudes.

The variations from year to year are even harder to adjust to than those from place to place and season to season. In order to compare the tropics with mid-latitudes in this regard, comparison was made between the rainfall totals of the wettest and driest years of record in many scattered cities in both zones. In brief, few mid-latitude cities received 2½ times as much rainfall in their wettest year as in their driest, but practically all tropical records reveal that much or more variability. This condition is present even in islands located far from continents and not in regions of frequent tropical cyclones. For example the average of the entire Hawaiian group (150 stations) was morethan twice as great in 1919 as in 1918 (112.9 inches vs. 54.5 inches).

Heavy downpours in short periods were also illustrated. For example more than 10 inches of rain in 24 hours have often been recorded in tropical Australia and elsewhere, and more than 20 inches repeatedly. The world's record of 46 inches in 24 hours is from near Manila, and there are numerous records of over 30 inches in three days. Rainfalls of 4 inches in 24 hours are very rare in mid-latitudes.

The conclusions drawn were that the rainfall regime characteristic of most of the tropics is a very serious handicap to their development. This was specifically applied to tropical Australia.

A. E. Waller.

The Dams of the Miami Conservancy and the Vegetation of their Slopes.

The project of building dams for flood prevention purposes only followed the 1913 disaster in the Miami Valley. Construction work was begun in 1918 and completed in three years. The dams are of earth, erected by the hydraulic fill method of construction. The surfaces of the slopes are of the locally obtained materials and vary greatly in their textures, being mostly of gravelly composition. They must be protected by a cover of vegetation to prevent erosion at all seasons and to prevent wave action during flood periods. Under the particular conditions the problem of obtaining a suitable cover for the slopes is an acute one.

Wellington D. Jones.

Detailed Field Mapping in the Study of the Economic Geography of the Agricultural Areas.

The problem of what factual material should be mapped and how it should be mapped in connection with the study of the economic geography of an agricultural area was considered by a small group of geographers in a recent three days' field meeting. Tentative conclusions are here presented.

R. H. Whitbeck.

The Valley of Chile.

Because of light rainfall and mountainous topography, only about one-fourth of the land of Chile is suited to crops and livestock; a half of this is thin, semi-arid pasturage. Two or three per cent of the total land of Chile is under the plow, and three per cent is under irrigation. Virtually all of the productive land is in the Central Valley, 600 miles long by 25 or 30 miles wide. It is a deeply-filled structural valley similar to that of California. This valley and the adjacent coast contain ninety per cent of the population of the country. In the northern half of the valley irrigation is largely depended upon, but only slightly so in the southern half. Very large landed estates prevail; one-half of one per cent of the population own 59 per cent of the farm land. The climate is delightful and the soil excellent, but the light rainfall, and crude methods of agriculture, poor country roads, uneducated and underpaid labor, and absentee ownership of estates keep agricultural production far below its possibilities. For geographical reasons mainly, wheat occupies four times as much land as all other cereals combined. Chiefly for climatic reasons, twice as much land is devoted to grapes as to all other fruits together, and wine-making is one of the leading industries of Chile.

The transportation service of the longitudinal railway and its many spurs, the invigorating climate, the energetic and patriotic population, the (usually) stable government, and the general spirit of progress which has resulted, make the Valley of Chile the outstanding geographical region of the West Coast of South America.

H. N. Whitford.

Geographic Aspects of the Production and Consumption of Rubber.

This paper discusses, by charts and maps, geographical regions that produce wild and planted rubber, and deals with the past, present and future possibilities of these regions. It traces the world movement

of rubber from its primary markets to the various consuming centers. It describes the climatic conditions suitable for growing rubber.

D. S. Whittlesey.

A Tentative Map of Geographic Regions of Africa—Read by Title.

A geographic region expresses unity in relationship between life conditions and conditions of the natural environment.

It is allied to natural regions, and to regions of human activities, but it is not identical with either.

A major geographic region is the largest area in which geographic unity appears.

Comment upon a few selected regions will serve to illustrate the foregoing principles:

a. Angola, a region of destructive exploitation.
b. Nigeria, a region of external organization for mutual profit.
c. The Sahara, a region of climatic isolation and overcrowding.
d. Abyssinia, a region of self-sufficient remoteness.
e. Rhodesia, a region of experimental colonization.
f. South Africa, a subtropical battle ground of races.